



Test Report No.: IC2209WDG0276-1



# TEST REPORT



Applicant	Particle Industries, Inc
Address	325 9th Street, San Francisco, CA 94103, United States Of America

Manufacturer or Supplier	Particle Industries, Inc
Address	325 9th Street, San Francisco, CA 94103, United States Of America
Product	Photon 2
Brand Name	Particle
Model	PHN2
Additional Model & Model Difference	N/A
Date of tests	Oct. 27, 2022 ~ Nov. 07, 2022

The tests have been carried out according to the requirements of the following standard:

- Canada RSS-247 Issue 2 (2017-02)
- Canada RSS-Gen Issue 5 (2021-02)

**CONCLUSION: The submitted sample was found to COMPLY with the test requirement**

Tested by Lucas Chen Project Engineer / EMC Department	Approved by Glyn He Assistant Manager / EMC Department
	
Date: Mar. 20, 2023	

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## RELEASE CONTROL RECORD

ISSUE NO.	REASON FOR CHANGE	DATE ISSUED
IC2202WDG0092-1	Original release	May 19, 2022
IC2209WDG0276-1	Based on the original report IC2202WDG0092-1, changed the applicant/manufacturer address, product name, model number and added the debugging base, it needed to be retested conducted emission and radiated emission (below 1GHz) after engineer evaluated.	Mar. 20, 2023



## 1 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

APPLIED STANDARD: RSS-247; RSS-Gen			
Standard	Test Type and Limit	Result	Remark
RSS-Gen			
8.8	AC Power Conducted Emission	PASS	Meet the requirement of limit
8.9 Table 5	Transmitter Radiated Emissions (Below 1GHz)	PASS	Meet the requirement of limit.

## 2 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

MEASUREMENT	FREQUENCY	UNCERTAINTY
Conducted emissions	9kHz~30MHz	3.05dB
Radiated emissions	9KHz ~ 30MHz	2.16dB
	30MHz ~ 1GMHz	3.82dB

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of  $k = 2$ .



### 3 GENERAL INFORMATION

#### 3.1 GENERAL DESCRIPTION OF EUT

<b>PRODUCT</b>	Photon 2
<b>MODEL NO.</b>	PHN2
<b>ADDITIONAL MODEL</b>	N/A
<b>IC</b>	20127-P2
<b>NOMINAL VOLTAGE</b>	5.0Vdc (Adapter) 3.7Vdc (Li-ion, Battery)
<b>MODULATION TECHNOLOGY</b>	DTS
<b>MODULATION TYPE</b>	GFSK(1& 2Mbps)
<b>OPERATING FREQUENCY</b>	2402-2480MHz
<b>OUTPUT POWER(PEAK)</b>	9.354mW (Max. Measured)
<b>ANTENNA TYPE</b>	PCB Antenna, 2.41dBi Gain External PCB Antenna, 1.55dBi Gain
<b>I/O PORTS</b>	Refer to user's manual
<b>CABLE SUPPLIED</b>	N/A
<b>PRODUCT SW/HW</b>	v1.0/ v1.0.0.
<b>RADIO SW/HW</b>	v1.0/ v1.0
<b>TEST SW VERSION</b>	Bluetooth RF Test Tool (5.3.1.60/5.2.2.98)
<b>RF POWER SETTING IN TEST SW</b>	0x06 for BT-LE 1M bps; 0x03 for BT-LE 2Mbps

#### NOTES:

1. For a more detailed features description, please refer to the manufacturer's specifications or the user's manual.
2. For the test results, the EUT had been tested with all conditions, but only the worst case was shown in test report.
3. Please refer to the EUT photo document (Reference No.: 2209WDG0276-1) for detailed product photo.
4. Conformity Assessment Body Identifier (CABID): CN0026
5. The Photon 2 uses two antennas, but couldn't transmit simultaneously, the antenna type and gain are different, and the antenna port is the same, so the RF conducted output power is the same. EIRP, Radiated emission and conducted emission have been evaluated for both antennas respectively, EIRP data for both antennas are shown in the report, but only the worst antenna data (PCB antenna) is shown in the test report for the radiation spurious emission test and conducted emission.



6. The EUT provides completed transmitters and receivers, the EUT uses only one antenna at any time.

<b>MODULATION MODE</b>	<b>TX FUNCTION</b>
BLE (1&2Mbps)	1TX/1RX

### 3.2 DESCRIPTION OF TEST MODES

40 channels are provided for BT-LE (1, 2 Mbps):

CHANNEL	FREQ. (MHZ)	CHANNEL	FREQ. (MHZ)	CHANNEL	FREQ. (MHZ)	CHANNEL	FREQ. (MHZ)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

#### 3.2.1. CONFIGURATION OF SYSTEM UNDER TEST

Please see section 5 photographs of the test configuration for reference.

#### 3.2.2. TEST MODE APPLICABILITY AND TESTED CHANNEL DETAIL

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis, power supply voltage range and antenna ports. The worst case was found when positioned on X axis for radiated emission. Following test modes were selected for the final test, and the final worst case is marked in boldface and recorded in the report:

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE<1G	RE≥1G	PLC	APCM	
<b>A</b>	√	-	√	-	Powered by DC 5V from Notebook with BT link

Where **RE<1G**: Radiated Emission below 1GHz      **RE≥1G**: Radiated Emission above 1GHz  
**PLC**: Power Line Conducted Emission      **APCM**: Antenna Port Conducted Measurement

**RADIATED EMISSION TEST (BELOW 1GHz):**

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports (if EUT with antenna diversity architecture).
- Following channel(s) was (were) selected for the final test as listed below.

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
BT-LE	0 to 39	39	DTS	GFSK	1
BT-LE	0 to 39	39	DTS	GFSK	2

For the test results, only the worst case was shown in test report.

**POWER LINE CONDUCTED EMISSION TEST:**

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, antenna ports (if EUT with antenna diversity architecture), and packet types.
- Following channel(s) was (were) selected for the final test as listed below.

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
BT-LE	0 to 39	39	DTS	GFSK	1
BT-LE	0 to 39	39	DTS	GFSK	2

For the test results, only the worst case was shown in test report.

**TEST CONDITION:**

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	TEST VOLTAGE	TESTED BY
RE<1G	25deg. C, 55%RH	DC 5V from Notebook	Stalker
PLC	25deg. C, 58%RH	DC 5V from Notebook	Summer



### 3.3 GENERAL DESCRIPTION OF APPLIED STANDARDS

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

**Canada RSS-247 Issue 2 (2017-02)**

**Canada RSS-Gen Issue 5 (2021-02)**

ANSI C63.10-2013

Note: All test items have been performed and recorded as per the above standards.

### 3.4 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

NO.	PRODUCT	BRAND	MODEL NO.	SERIAL NO.	FCC ID
1	Notebook	DELL	Inspiron 13-7378	GMSJZD2	N/A
2	Serial port tool	N/A	N/A	N/A	N/A

NO.	SIGNAL CABLE DESCRIPTION OF THE ABOVE SUPPORT UNITS
1	AC Line: Unshielded, Detachable 0.8m; DC Line: Unshielded, Non-detachable 1.8m; USB Cable: Shielded, Detachable, 0.5m
2	N/A

## 4 TEST TYPES AND RESULTS

### 4.1 CONDUCTED EMISSION MEASUREMENT

#### 4.1.1 LIMITS OF CONDUCTED EMISSION MEASUREMENT

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dB $\mu$ V)	
	Quasi-peak	Average
0.15 ~ 0.5	66 to 56	56 to 46
0.5 ~ 5	56	46
5 ~ 30	60	50

- NOTES:**
1. The lower limit shall apply at the transition frequencies.
  2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.
  3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

#### 4.1.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Next Cal.
EMI Test Receiver	Rohde&Schwarz	ESR7	101494	Jan. 18,23
Artificial Mains Network	Rohde&Schwarz	ENV216	101173	Jan. 23,23
Artificial Mains Network	Rohde&Schwarz	ESH3-Z5	100317	Jan. 18,23
Voltage probe	SCHWARZBECK	TK 9421	TK 9421-176	Aug. 05,23
Coaxial RF Cable	/	CE CABLE	C2310066DG	Jul. 27,23
Test software	ADT	ADT_Cond_V7.3.7	N/A	N/A

- NOTES:**
1. The test was performed in shielded room 553. (Chenwu)
  2. The calibration interval of the above test instruments is 12 months. And the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

#### 4.1.3 TEST PROCEDURES

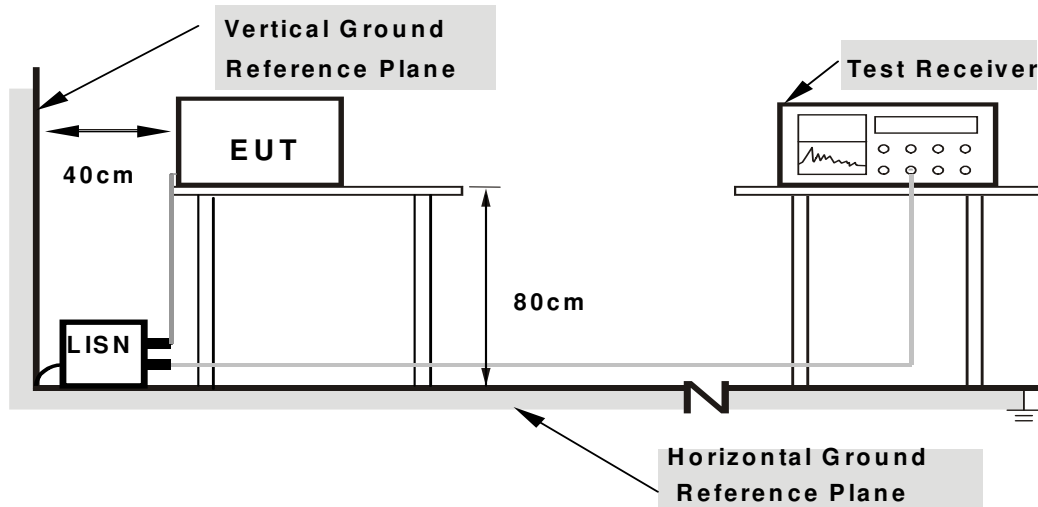
- a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.
- b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

**NOTE:** All modes of operation were investigated and the worst-case emissions are reported.

#### 4.1.4 DEVIATION FROM TEST STANDARD

No deviation.

#### 4.1.5 TEST SETUP



**Note: 1.Support units were connected to second LISN.**

**2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes**

For the actual test configuration, please refer to the attached file (Test Setup Photo).

#### 4.1.6 EUT OPERATING CONDITIONS

- a. Turned on the power and connected of all equipment.
- b. EUT was operated according to the type used was description in manufacturer's specifications or the User's Manual.

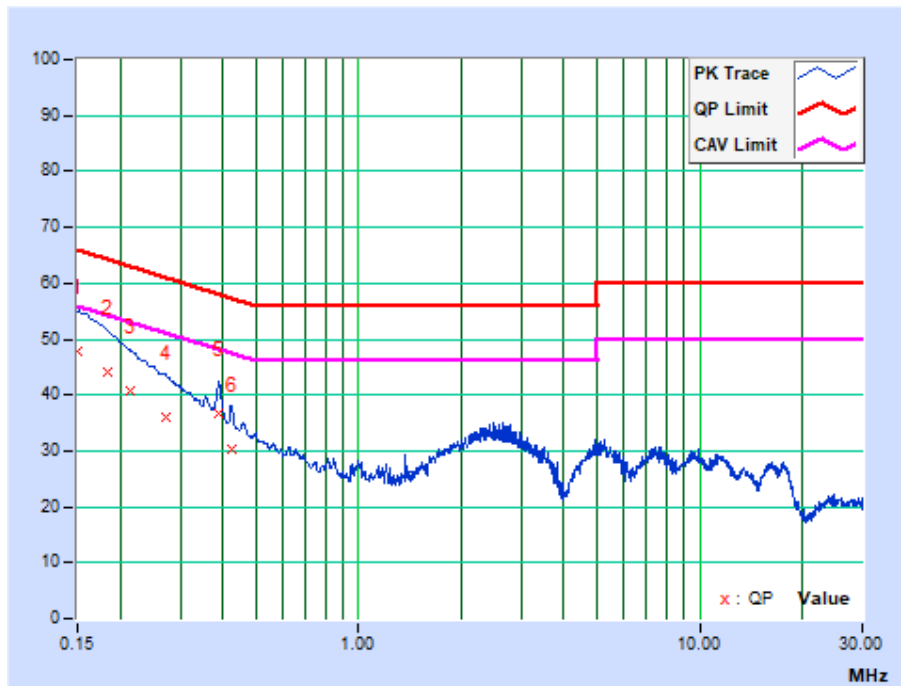
### 4.1.7 TEST RESULTS

**CONDUCTED DATA: BT Link (Worst-case PCB Antenna)**

<b>PHASE</b>	Line	<b>6dB BANDWIDTH</b>	9kHz
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No	Freq. [MHz]	Corr. Factor (dB)	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
			Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	9.82	38.14	11.39	47.96	21.21	66.00	56.00	-18.04	-34.79
2	0.18375	9.83	34.29	7.19	44.12	17.02	64.31	54.31	-20.19	-37.29
3	0.21300	9.85	31.02	10.60	40.87	20.45	63.09	53.09	-22.22	-32.64
4	0.27150	9.87	26.24	10.58	36.11	20.45	61.07	51.07	-24.96	-30.62
5	0.38871	9.90	26.90	24.57	36.80	34.47	58.09	48.09	-21.29	-13.62
6	0.42298	9.91	20.32	17.25	30.23	27.16	57.39	47.39	-27.16	-20.23

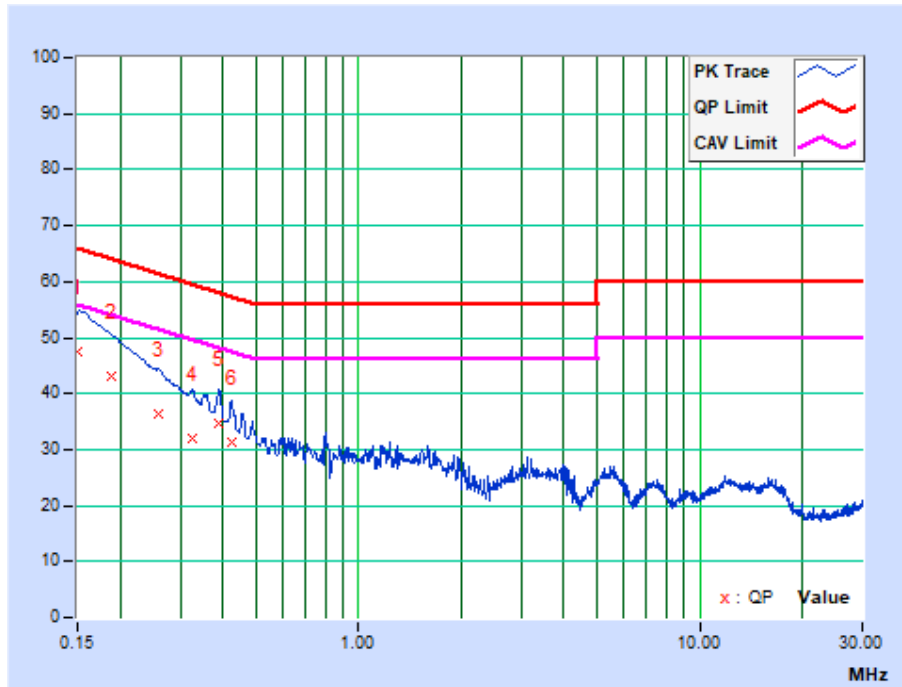
- REMARKS:**
1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
  2. "-": The Quasi-peak reading value also meets average limit and measurement with the average detector is unnecessary.
  3. The emission levels of other frequencies were very low against the limit.
  4. Margin value = Emission level - Limit value
  5. Correction factor = Insertion loss + Cable loss
  6. Emission Level = Correction Factor + Reading Value.



<b>PHASE</b>	Neutral	<b>6dB BANDWIDTH</b>	9kHz
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No	Freq. [MHz]	Corr. Factor (dB)	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
			Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	9.76	37.84	12.09	47.60	21.85	66.00	56.00	-18.40	-34.15
2	0.18825	9.77	33.39	8.76	43.16	18.53	64.11	54.11	-20.96	-35.59
3	0.25748	9.79	26.66	11.24	36.45	21.03	61.51	51.51	-25.07	-30.49
4	0.32483	9.80	22.31	12.22	32.11	22.02	59.58	49.58	-27.47	-27.56
5	0.39077	9.80	24.77	21.66	34.57	31.46	58.05	48.05	-23.48	-16.59
6	0.42298	9.81	21.51	19.57	31.32	29.38	57.39	47.39	-26.07	-18.01

- REMARKS:**
1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
  2. "-": The Quasi-peak reading value also meets average limit and measurement with the average detector is unnecessary.
  3. The emission levels of other frequencies were very low against the limit.
  4. Margin value = Emission level - Limit value
  5. Correction factor = Insertion loss + Cable loss
  6. Emission Level = Correction Factor + Reading Value.



## 4.2 RADIATED EMISSION MEASUREMENT

### 4.2.1 LIMITS OF RADIATED EMISSION MEASUREMENT

Radiated emissions which fall in the restricted bands, as defined in RSS-Gen Section 8.10, must also comply with the radiated emission limits specified in RSS-Gen Section 8.9. as following:

FREQUENCIES (MHz)	Magnetic field strength (H-Field) ( $\mu\text{A/m}$ )	MEASUREMENT DISTANCE (meters)
0.009 ~ 0.490	6.37/F (F in kHz)	300
0.490 ~ 1.705	63.7/F (F in kHz)	30
1.705 ~ 30.0	0.08	30

FREQUENCIES (MHz)	FIELD STRENGTH (microvolts/meter)	MEASUREMENT DISTANCE (meters)
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

**NOTE:**

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).



**4.2.2 TEST INSTRUMENTS**

<b>Equipment</b>	<b>Manufacturer</b>	<b>Model No.</b>	<b>Serial No.</b>	<b>Next Cal.</b>
EMI Test Receiver	Rohde&Schwarz	ESU40	100449	Mar. 07, 23
Signal and Spectrum Analyzer	Rohde&Schwarz	FSV7	102331	May 09, 23
Active Loop Antenna (9KHz -30MHz)	SCHWARZBECK	FMZB 1519B	1519B-045	May 20, 23
Amplifier (9KHz -1GHz)	Burgeon	BPA-530	100210	Mar. 13, 23
Bilog Antenna (20MHz -2GHz)	Teseq	CBL 6111D	30643	May 21, 23
Horn Antenna (1GHz -18GHz)	ETS -Lindgren	3117	00062558	May 21, 23
Horn Antenna (18GHz -40GHz)	SCHWARZBECK	BBHA 9170	BBHA9170147	May 14, 23
3m Semi-anechoic Chamber	ETS-LINDGREN	9m*6m*6m	NSEMC003	May 22, 23
Test Software	ADT	ADT_Radiated_V 7.6.15.9.2	N/A	N/A
Broadband Preamplifier (1GHz~18GHz)	SCHWARZBECK	BBV9718	305	May 12, 23
Pre-Amplifier (18GHz-40GHz)	EMCI	EMC 184045	980102	Jan. 10, 23
Test Software	ADT	ADT_Radiated_V 7.6.15.9.2	N/A	N/A
BLUETOOTH TESTER	Rohde&Schwarz	CBT32	100811	N/A

**NOTES:**

1. The test was performed in 966 Chamber. (Chenwu)
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.
3. The horn antenna is used only for the measurement of emission frequency above 1GHz if tested.
4. The IC test Site Registration No. is 5936A.



#### 4.2.3 TEST PROCEDURES

- a. The EUT was placed on the top of a rotating table 1.5 meters (above 1GHz) and 0.8 meters (below 1GHz) above the ground at a 3 meters semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. For below 1GHz was used bilog antenna, and above 1GHz was used horn antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f. For below 30MHz, a loop antenna with its vertical plane is place 3m from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. And the centre of the loop shall be 1.3m above the ground.
- g. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, For battery operated equipment, the equipment tests shall be perform using fresh batteries. The turntable was rotated to maximize the emission level.

#### NOTES:

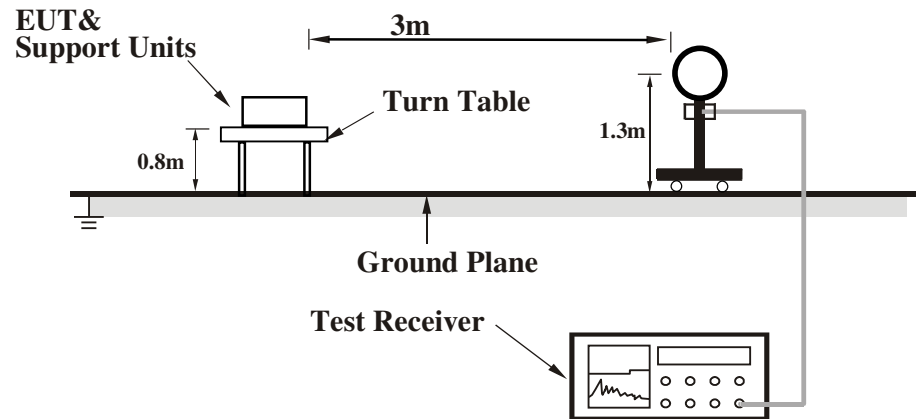
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and video bandwidth is 3MHz for Peak detection at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is  $\geq 1/T$  (Duty cycle < 98%) or 10Hz(Duty cycle > 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.
5. The testing of the EUT was performed on all 3 orthogonal axes; the worst-case test configuration was reported on the file test setup photo.

#### 4.2.4 DEVIATION FROM TEST STANDARD

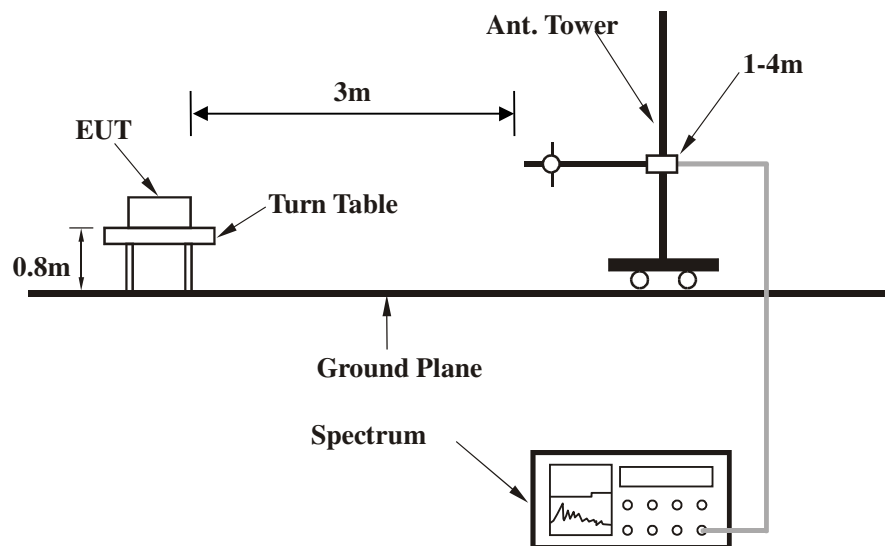
No deviation.

#### 4.2.5 TEST SETUP

##### Below 30MHz test setup

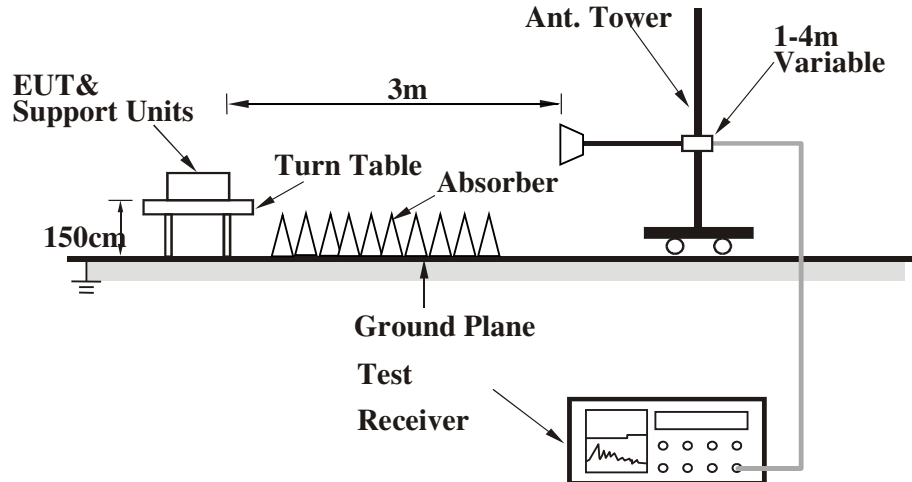


##### Below 1GHz test setup



**Note:** For the actual test configuration, please refer to the attached file (Test Setup Photo).

## Above 1GHz test setup



**Note:** For the actual test configuration, please refer to the attached file (Test Setup Photo).

### 4.2.6 EUT OPERATING CONDITIONS

- Set the EUT placed them on a testing table.
- Set the transmitter part of EUT under transmission condition continuously at specific channel frequency.
- The necessary accessories enable the EUT in full functions.

#### 4.2.7 TEST RESULTS

BELOW 1GHz DATA: (Worst-case PCB Antenna)

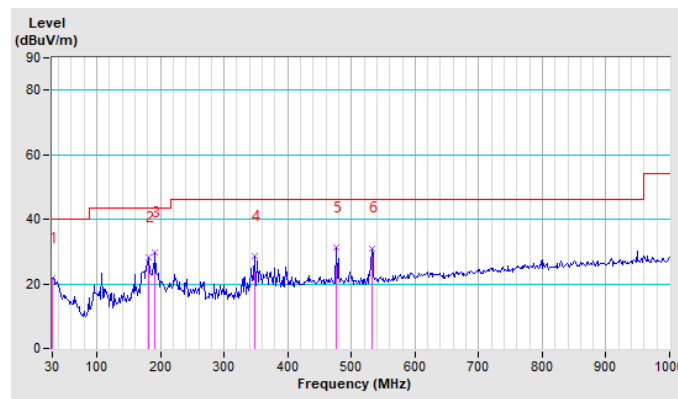
BT-LE GFSK (1Mbps)

<b>CHANNEL</b>	TX Channel 39	<b>DETECTOR FUNCTION</b>	Quasi-Peak (QP)
<b>FREQUENCY RANGE</b>	9KHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	30.00	21.59 QP	40.00	-18.41	2.00 H	250	39.37	-17.78
2	180.79	28.04 QP	43.50	-15.46	2.00 H	284	45.35	-17.31
3	191.67	29.78 QP	43.50	-13.72	2.00 H	268	47.97	-18.19
4	348.67	28.74 QP	46.00	-17.26	2.00 H	304	41.99	-13.25
5	476.14	31.16 QP	46.00	-14.84	2.00 H	322	40.79	-9.63
6	532.10	31.04 QP	46.00	-14.96	2.00 H	358	39.70	-8.66

**REMARKS:**

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
3. The emission levels of other frequencies were greater than 20dB margin.
4. 9KHz~30MHz have been test and test data more than 20dB margin.
5. Margin value = Emission level – Limit value

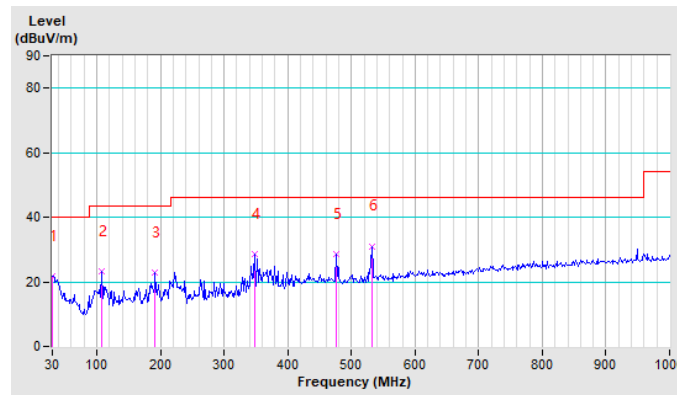


<b>CHANNEL</b>	TX Channel 39	<b>DETECTOR FUNCTION</b>	Quasi-Peak (QP)
<b>FREQUENCY RANGE</b>	9KHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	30.00	21.59 QP	40.00	-18.41	2.00 V	69	39.37	-17.78
2	107.72	23.39 QP	43.50	-20.11	2.00 V	45	42.96	-19.57
3	191.67	22.96 QP	43.50	-20.54	2.00 V	128	41.15	-18.19
4	348.67	28.74 QP	46.00	-17.26	2.00 V	324	41.99	-13.25
5	476.14	28.74 QP	46.00	-17.26	2.00 V	88	38.37	-9.63
6	532.10	31.04 QP	46.00	-14.96	2.00 V	241	39.70	-8.66

**REMARKS:**

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m).
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
3. The emission levels of other frequencies were greater than 20dB margin.
4. 9KHz~30MHz have been test and test data more than 20dB margin.
5. Margin value = Emission level – Limit value





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## 4 PHOTOGRAPHS OF THE TEST CONFIGURATION

Please refer to the attached file (Test Setup Photo).



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## 5 APPENDIX A - MODIFICATIONS RECORDERS FOR ENGINEERING CHANGES TO THE EUT BY THE LAB

No any modifications are made to the EUT by the lab during the test.

---END---